Radiation Physics Note 55

Neutron and Temperature Response of HPI 1010's

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I. Introduction

The anomalously low neutron response of the HPI 1010 (#2) used in R. P. Note 48 was studied in comparison to the other HPI 1010's at the lab. In addition, the temperature response was studied, as this has been a problem in the past.

II. Experimental Method

A. For the neutron response portion of the test, the method and sources described in R. P. Note 48 were used. No outdoor measurements were made, however. Data was taken only indoors at Site 68, in the second floor southeast corner room. No correction is made for possible neutron enhancement through scatter.

B. For the temperature portion of the test, the environmental chamber was used to vary the temperature of the instruments while they were being exposed to neutrons (PuBe 238-5.5-1) and then gammas (15 each Cs 137-0.3-xx). The target temperatures were -20°C, +25°C and +50°C. The instruments were allowed to stabilize at the desired temperature for about a day before readings were taken.

III. Results

A. The results of the neutron tests are given in Table 1. The column labelled "Ratio Measured/Expected" has been adjusted for background subtraction, calibration correction factor, gamma component subtraction, and then compared to the expected neutron dose rate of 0.54 mRad/hr. The column labelled "Error % Neutron Response" indicates the amount of under-response to neutrons.

The neutron responses for the HPI 1010's varied from -27% to -48%, with the average being -40%. Although all HPI 1010's under-responsed, the one (#2) used for R. P. Note 48 happened to be the worst (-48%). The best response (-27%) came from chamber S/N 213. This is type A150 plastic. The other chambers are type A174. The data also indicates that the neutron response was slightly better for radial (side) exposure than for axial (front) exposure. For those instruments tested both ways, the average radial response was -35%, while the average axial response was -44%.

B. The results of the temperature tests are given in Table 2. All

of the instruments have negative temperature coefficients ranging from -0.13%/°C to -0.66%/°C for neutron and -0.15%/°C to -0.66%/°C for gamma. The average is -0.38%/°C. Individual instruments have similar neutron and gamma temperature responses. Graph 1 and Graph 2 indicate the slopes for the temperature responses for neutron and gamma, respectively. The slopes are steepest for +25°C to +50°C.

IV. Conclusions

A. These tests confirm the low neutron response of HPI 1010 #2 used for R. P. Note 48. In addition, HPI 1010's as a species have low neutron responses, though #2 was the worst tested. For best neutron response, the instruments should be calibrated and used with the source of the radiation to the side (radial). The single instrument with type A150 plastic has a better neutron response than the others with A174 type. Also, there is a large variation in neutron response from instrument to instrument.

B. All of the instruments tested have negative temperature cofficients. The error slope becomes greater with higher temperatures. There is a large variation in temperature response from instrument to instrument.

TABLE 1

Comparison of HPI 1010 neutron response

Body #	Chamber #	Plastic #	Orientation	Background Reading	Gamma Cs 137-3.5-1 Meter Reading	Gamma Cs 137-3.5-1 BKgnd. Subtr.	Gamma Cs 137-3.5-1 Correct. Factor	Neutron PuBe 238-7.2-1 meter Reading	Neutron PuBe 238-7.2-1 BKgnd. Subtr.	Neutron PuBe 238-7.2-1 Correct Reading	Neutron PuBe 238-7.2-1 Gamma Subtr.	Ratio Meas./Expect.	Error % Neutron Response	Comments
1	CB0	A174	radial	.0159	.41	.393	.905	.60	.584	.529	.349	.65	-35%	
1	213	A150	radial	.0132	.3975	.3843	.926	.635	.622	.576	.396	.733	-27%	Loaned from HPI - now on Body # 2
2	C79	A174	axial	.0133	.41	.3967	.897	.53	.517	.464	.284	.525	-47%	used in RP note #48
2	C79	A174	radial	.0133	.39	.3767	.945	.50	.487	.460	.280	.518	-48%	used in RP note #48
3	C60	A174	axial	.0153	.3975	.3822	.931	.54	.525	.489	.309	.572	-43%	
3	C60	A174	radial	.0153	.385	.3697	.963	.555	.540	.512	.340	.63	-37%	
4	C501	A174	axial	.017	.4175	.4005	.889	.58	.563	.500	.320	.593	-41%	
4	C501	A174	radial	.017	.415	.398	.894	.64	.623	.557	.377	.698	-30%	
2	C79	A174	axial	.016	.402	.386	.922	.498	.482	.444	.265	.49	-51%	old data from RP note #48
173	New chipmunk		radial	.167	.566	.399	.892	.944	.827	.738	.558	1.03	+3%	For comparison

Notes: Cs 137-3.5-1 dose rate = .372 mR/hr x .957 mRad/hr / mR/hr = .356 mRad/hr

Correction Factor = .356 mRad/hr / meter reading.

Corrected Reading = meter reading x correction factor.

PuBe 238-7.2-1 dose rate = .54 mRad/hr neutron + .18 mRad/hr gamma

Measurements made at site CB, second floor, SE corner room.

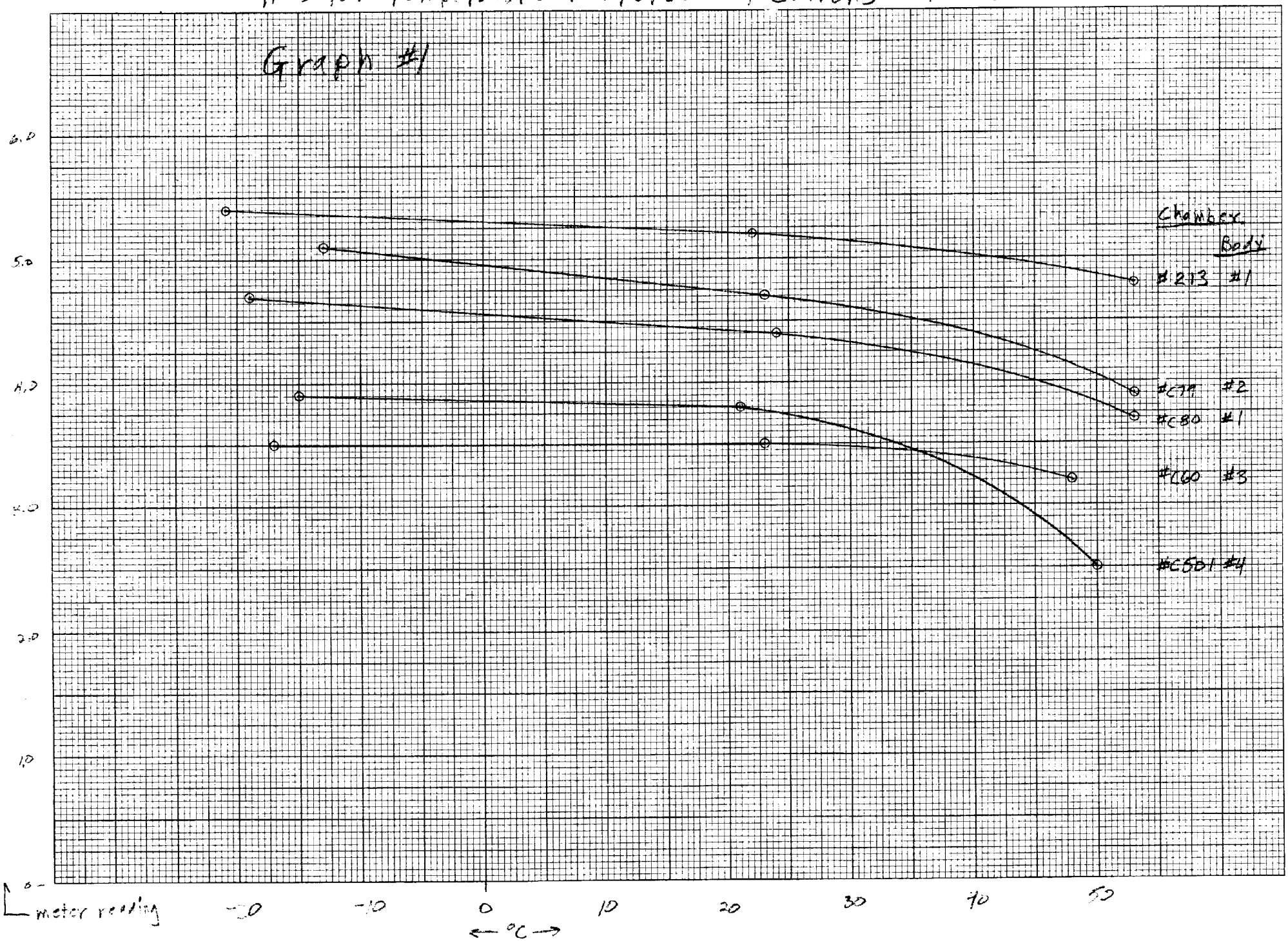
			Neutrons PuBe238-5.5-1				Gamma 15 each Cs137-0.3-xx				
Body #	chamber #	plastic #	cold reading	room reading	hot reading	slope	cold reading	room reading	hot reading	slope	comments
1	213	A150	5.4 -21°C	5.2 22°C	4.3 58°C	-.28%/°C	5.1 -16°C	4.8 22°C	4.1 61°C	-.32%/°C	Loaned from HPI - now on body # 2
1	C80	A174	4.7 -19°C	4.4 24°C	3.7 53°C	-.32%/°C	4.9 -14°C	4.3 23°C	3.7 53°C	-.39%/°C	
2	C79	A174	5.1 -13°C	4.7 +23°C	3.9 53°C	-.39%/°C	3.5 -12°C	3.2 22°C	2.8 49°C	-.36%/°C	used in RP Note # 48
3	C60	A174	3.5 -17°C	3.5 23°C	3.2 48°C	-.13%/°C	2.9 -15°C	3.0 23°C	2.6 50°C	-.15%/°C	Best Temperature response
4	C501	A174	3.9 -15°C	3.8 21°C	2.5 50°C	-.57%/°C	3.4 -20°C	2.8 23°C	2.1 50°C	-.66%/°C	worst Temperature response

TABLE 2

Comparison of HPI 1010 Temperature Response for Neutrons and Gamma

HPI 1010 Temperature response - Neutrons - PuBe [illegible]8-5,5-1

Graph #1



HPI 1010 Temperature response — Gamma - Cs 137

Graph #2